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ADDITIONAL NOTES ON *DEGENERIA VITIENSIS*

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With one plate and one text-figure

WHEN THE FAMILY Degeneriaceae was proposed in 1942 (in Jour. Arnold Arb. 23: 356–365. *pl.* 1–5) by Prof. I. W. Bailey and the writer, it must have seemed to some readers that we were highly optimistic in suggesting that a new species based on only two known collections be immediately established as representing a monotypic family. Few plant families have such an abrupt inception. It is more traditional to refer a genus of doubtful affinities to some presumably allied family, in which it may languish for many years or decades, until the researches of monographers exclude it from all likely families and establish that it merits family rank. Even then the position of the genus is suspect, for many herbarium custodians are allergic to monotypic or small families and, rather than alter their system, cling to unwieldy plant-groupings which have no morphological justification. Whether the family Degeneriaceae will be accepted in herbaria or will be thrust into a distended “magnoliaceous” concept (which already in some herbaria includes highly discordant elements) remains to be seen.

However, in 1942 Prof. Bailey and I could not bring ourselves to place our new genus *Degeneria* in either the Magnoliaceae or Himantandraceae, clearly the only existing families of its immediate alliance. The discovery of a third collection, from southeastern Viti Levu (cf. Bull. Torrey Club 70: 537. 1943), did not add to our knowledge of the morphology of the genus. In order to verify our conclusions or to make possible a re-evaluation of our family concept, new material for morphological and anatomical study was clearly desirable. Consequently, when I had an opportunity to undertake a second collecting trip to Fiji in 1947,¹ one of

¹The collections upon which this study is primarily based were obtained in Fiji between April, 1947, and January, 1948, in the course of exploration under the auspices of the Arnold Arboretum of Harvard University. Generous financial support was supplied by the John Simon Guggenheim Memorial Foundation, the Penrose Fund of the American Philosophical Society, and the Bache Fund of the National Academy of Sciences. To these organizations the writer is deeply grateful.

my primary objectives was to locate, if possible, additional specimens of *Degeneria vitiensis* and to obtain material for study by my colleagues Prof. Bailey and Dr. B. G. L. Swamy. It is not within the scope of this treatment to discuss in detail the morphological aspects of *Degeneria*, now somewhat better known than in 1942, which justify its position in a distinct family. In the following article in this Journal, Dr. Swamy ably analyzes the characters of our genus. Here I shall refer only to the occurrence, habit, and habitat of *Degeneria vitiensis*, on the basis of my field-study of it in 1947.

OCCURRENCE

The principal purpose of the Fijian exploration mentioned above was the acquisition of herbarium material which would permit a better knowledge of the flora and which would widen the basis for future floristic studies of the archipelago. Consequently I attempted to visit those regions which had been comparatively neglected by previous collectors. The first six months were spent on Viti Levu, for the most part at higher elevations. My first objectives were the two forested mountain-ranges which stand above the predominantly reed-covered western portion of Viti Levu—the Mt. Evans and Mt. Koromba Ranges. During two months in this area no specimens of *Degeneria* were found. Subsequently a base was established at Nandarivatu, a now nearly deserted government station on the northern escarpment of Viti Levu at an elevation of about 800 meters. From this base numerous trips southward, into the extensive forested area drained by the upper Singatoka River, were made. During June and July the forested area dominated by Fiji's highest peak, Tomanivi [Mt. Victoria], was explored without observation of *Degeneria*. Degener's type-locality is in the vicinity of a small Fijian settlement, Nauwanga, which lies in the valley of Nandala Creek (one of the Singatoka headwaters) a few miles south of Nandarivatu; I did not work in that immediate vicinity in detail.

Due to other interests, I had relegated the search for *Degeneria* to a lesser position when I began to work southward from Tomanivi onto the Rairaimatuku Plateau, a poorly drained, uninhabited, and essentially uncollected upland region, about 25 by 15 miles in size, occupying the center of Viti Levu. It was, therefore, an exciting surprise to find the desired species. Collectors will agree with me that the rediscovery of a rare plant gives an emotional pleasure incomparably greater than its original discovery, at which time it is unexpected and usually unrecognized. For my part, I have no remembrance whatever of my first collection of *Degeneria* on Vanua Levu in 1934. But the date (August 7, 1947) and the place of my second collection of the species will not be forgotten by me. From my headquarters in the village of Nandrau, which lies on the steep western slope of the plateau in the Singatoka valley, I was working toward the smaller village of Nanga, which is similarly situated a few miles to the south. The trail between these villages leads through the dense forest of the plateau a mile or two from its edge. We had left this trail and were

slowly progressing through the forest toward the east, over the rounded summit of a small elevation, when one of my Fijian assistants brought me a strange fruit from the forest-floor. (It is fortunate for most of us who collect in tropical forests that we have keen-eyed native helpers, without whom we would overlook many discoveries for which our herbarium-labels unblushingly give us the credit.) After we located the tree — and this was not easy in the dense-foliaged rain-forest — I had plenty of time to compose myself, for it proved to be one of those stubborn trees, bound to others by lianas, which takes half an hour to fell. Once the tree was down and I had reassured myself it was really a specimen of the elusive *Degeneria*, we searched it thoroughly and obtained material for numerous herbarium specimens.

This individual was in the same condition as my Vanua Levu collection, with small fruits in the stage of development which Prof. Bailey and I had erroneously assumed to be mature in our original study. None of my field-crew had seen the species before, but in the village of Nanga one old man assured us that it was very rare but that he knew it by the name of *vavaloa*, which can be translated as "black shoe." The aptitude of this name is apparent only when one has seen the mature fruit.² In other parts of Fiji the species appears to be known as *yaranggele* (in the Wainunu region of Vanua Levu) or *masiratu* (in southern Naitasiri, Viti Levu).

My field-crew, now being aware of the identity of the plant and of my desire for adequate flowering material, sought carefully for additional specimens, but none were forthcoming on the Rairaimatuku Plateau. However, after we had returned to the vicinity of Tomanivi we discovered the species with increasing frequency, as it became more familiar to us. On September 2, not far from a sawmill which operates at the western base of Tomanivi, we found individuals in full flower and with mature fruits. Later, we found the species in some abundance very near Nandarivatu, in the precise locations which had earlier been searched in vain. The area immediately adjacent to Nandarivatu and Tomanivi has been examined by several highly competent collectors, including Gibbs, im Thurn, Gillespie, and Degener. That none of them except the last obtained specimens of this genus need cause no surprise. Like most trees of the upper storey of the rain-forest, the *vavaloa* mingles its branches and foliage with those of many other species, and even when the tree is in full flower or fruit these organs are not visible from the ground. It is only an occasional clue — a fruit or the vascular skeleton of one on the forest-floor — that indicates the presence of the plant, and such clues can readily be overlooked or ignored by one unfamiliar with the plant. Eventually my Fijian friends learned to recognize *Degeneria* at a glance by its bark, but I believe that only a trained forester could equal them in this respect.

² I have also recorded the name *vavaloa* as applied, on one occasion, to *Oxymitra monosperma*, which has a fairly large inequilateral mature carpel, and on another occasion to *Hernandia olivacea*. There is no literal reason for the latter application, and my informant was probably over-enthusiastic.

Altogether I observed and made notes upon 55 trees of *Degeneria* during August, September, and October of 1947. From ten of these herbarium specimens were taken, in addition to wood samples and abundant material in preservative. It is obvious that the observed individuals form only a minute fraction of the total population; there must be many thousands of *Degeneria* trees in the region explored. This region may be defined as the northern part of the forest which covers the central portion of Viti Levu, and it may be circumscribed by a semi-circle, with a radius of less than 15 miles, lying due south of Nandarivatu. The area would fall into the old Province of Tholo North, now divided among the four Provinces of Mba, Nandronga & Navosa, Ra, and Naitasiri.

Degeneria vitiensis can no longer be considered rare in upland Viti Levu, but of course it cannot be described as common when compared with some of the characteristic species listed later in this paper. To the southward and southeastward of the region discussed above the forest seems essentially similar, and it is likely that the same frequency of *Degeneria* would be maintained on the entire central plateau of the island and in the forests drained by the Rewa and Navua tributaries. In favorable localities it occurs close to sea-level, as attested by Mr. B. E. Parham's collections of it in southeastern Viti Levu and my own in Vanua Levu.

It seems advisable to list here all the herbarium specimens of *Degeneria vitiensis* at present known; they are arranged in general from north to south on Viti Levu. My own 1947 collections are deposited in the herbarium of the Arnold Arboretum, and numerous duplicates will later be distributed. Mr. Parham's collections are in the herbarium of the Department of Agriculture, Suva, with duplicates at the Arnold Arboretum.

VITI LEVU: M b a : Hills between Nandala and Nukunuku Creeks, along trail from Nandarivatu toward Lewa, alt. 750–850 m., *Smith* 6170, 6190; western slopes of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, alt. 850–900 m., *Smith* 6301, 6318; hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–950 m., *Smith* 5923; Nauwanga, valley of Nandala Creek south of Nandarivatu, alt. 750 m., *Degener* 14537 (TYPE, Arnold Arb.; duplicates widely distributed), Feb. 24, 1941; hills between Nggaliwana and Tumbeindreketi Creeks, east of the sawmill at Navai, alt. 750–800 m., *Smith* 5875, 5880, 6018 (juvenile); southwestern slopes of Mt. Tomanivi (Mt. Victoria), alt. about 850 m., *Smith* 5744; N a n d r o n g a & N a v o s a : Northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, alt. 725–835 m., *Smith* 5555; N a i t a s i r i : Nanduna, Waindina River, Navuakethe district, alt. 90–120 m., *B. E. Parham* 1488 (March 7, 1939), 3008 (June 19, 1945).³ VANUA LEVU: M b u a : Lower Wainunu River valley, alt. 0–200 m., *Smith* 1754 (duplicates in several herbaria), May 7, 1934.

These localities are indicated on the accompanying map (*fig. 1*), which also shows in an extremely approximate manner the boundary between

³ Mr. Parham kindly arranged to have a Fijian assistant in the Department of Agriculture, Apenito Gonekalou, visit this same locality on Jan. 4, 1948. Several trees were observed but no flowers or fruits could be obtained. However, Apenito obtained several seedlings, which were preserved in FAA and which have been studied by Prof. Bailey and Dr. Swamy. My own several attempts to germinate seeds at Nandarivatu failed, and seeds which were returned to Harvard by air-mail likewise proved unviable.

forest and grassland. Actually, of course, this boundary is a fairly wide and complex transitional zone.

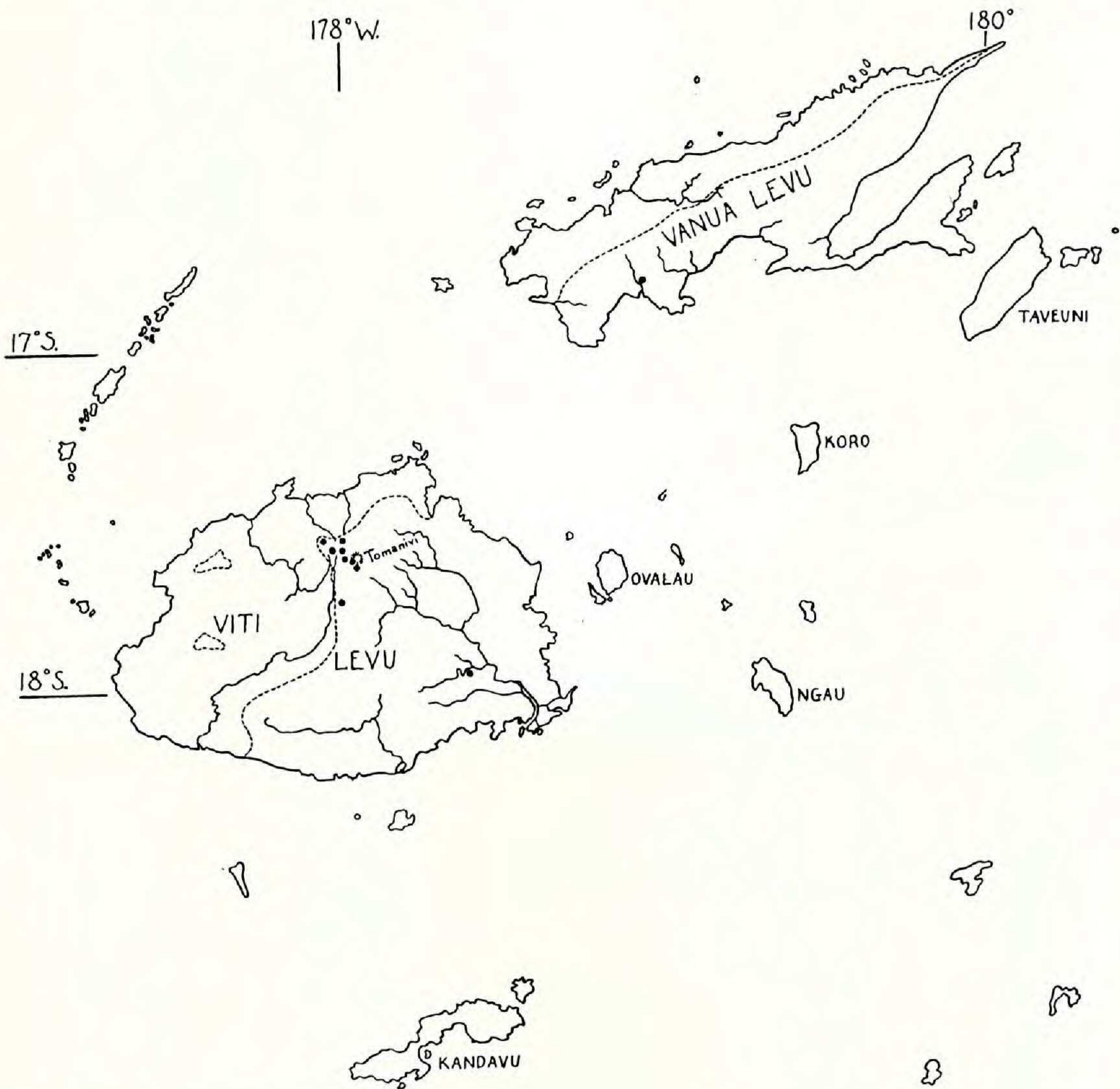


FIG. 1. Sketch map of western Fiji (Lau Group omitted), showing known stations for *Degeneria vitiensis*. The dotted lines show the approximate boundaries, on the two large islands, between forested and grassland areas.

To summarize this discussion of the occurrence of *Degeneria vitiensis*, field-observations lead me to suppose that it may eventually be found in any undisturbed rain-forest area of Viti Levu and Vanua Levu between sea-level and approximately 950 meters. It should also be sought in the forested regions of the islands of Taveuni, Koro, Ovalau, Ngau, and Kandavu, although these forests appear much less diverse in composition than those of the two large islands. I have not observed the species at higher elevations than 950 m.; from this point, to the crests of ridges and summits of peaks the trees are smaller and frequently gnarled, with more abundant epiphytes and cryptogams. The highest elevation in Fiji is 1323 meters, on the summit of Tomanivi, but several hills on Viti Levu exceed 1000 meters. The highest elevation on Vanua Levu is 1030 meters,

on the summit of Mbatini. Conditions of exposure in the Vanua Levu hills seem to be such that the truly montane forest reaches lower elevations than it does on Viti Levu, and consequently *Degeneria* is not anticipated above 700 or 800 meters on Vanua Levu.

HABIT

Seedlings which could be positively assigned to *Degeneria* were not observed by me personally, but fortunately those collected in Naitasiri, mentioned above, are available for study; their salient features are discussed by Dr. Swamy in the following paper.

The juvenile plant is a slender treelet with a spreading crown and very large leaves. Although the petioles of these leaves are no longer than some observed on mature trees, the blades are conspicuously larger, attaining a size of 25–45 × 10–14 cm. They are sometimes gradually attenuate to the base and long-decurrent on the petiole, while the apex may be deltoid-cuspidate and as much as 1 cm. long, a character not observed in mature leaf-blades, which seem always to be either rounded or lightly emarginate at the apex. The juvenile leaf-blades sometimes have as many as 30 pairs of principal secondary nerves, whereas those of mature plants seldom have more than 18 such pairs.

The mature tree, like most species of the Fijian rain-forest, is extremely slender for its height, with a freely branching crown and dense foliage. At apparently maximum growth it may be from 18 to 30 meters high, at which stage its trunk has a breast-high diameter of only 45–70 cm. Characteristically the trunk has 3–7 fairly obvious rounded buttresses, these being usually apparent upward for about one or rarely for two meters. The individual portrayed in PL. 1, *fig. A*, is only half-grown and does not have the buttresses well developed. The bark is dark gray and comparatively thick, with rather regular fissures.

Apparently our two original collections were diverse enough to cover essentially all the dimensional foliar variation now known. It may be repeated that the leaf-blades of mature trees are extremely variable in size, sometimes only 5 × 2.5 cm. (our original dimensions having been 9–27 × 3.5–13.5 cm.). The principal secondary nerves may be as few as 8 per side (originally stated as 10–18).

Some specimens of *Degeneria* observed in 1947 were spectacularly loaded with flowers, but, as mentioned above, the effect of this prolific flowering is lost in the forest-canopy. Fully open flowers are sometimes 5 cm. in diameter, but they disintegrate and lose their petals very quickly. At anthesis they emit a pleasing fragrance suggestive of that of some anno-naceous flowers, e.g. *Cananga odorata*.

Dissection of preserved flowers and fruits by Dr. Swamy permits the following emendation of the original description. The sepals are very rarely 4 in number, although 3 is certainly the characteristic number. The petals (originally mentioned as 12 or 13 in number) are seen to be occasionally as many as 18; they are arranged in 3–5 series, and the

maximum size now observed is 24×14.5 mm. (originally stated as 19×12 mm.). The stamens may be 20–30 in number and 3- or 4-seriate; the largest ones observed are 9.5×2.5 mm. (originally stated as 6×2.5 mm.), with thecae up to 5 mm. long. The staminodes are 10–13 in number (rather than 11 or 12) and up to 7×3.5 mm. in size. The carpel is practically always single, as previously stated. However, in one dissection Dr. Swamy found two carpels in a flower, and one of my herbarium specimens (no. 5555) shows a single instance of two developing fruits. The number of ovules varies considerably beyond the 24 or 26 mentioned originally, being as now observed 20–32, although the extreme numbers are rare. The fruiting pedicel sometimes attains a length of 5 cm. The mature fruit has not previously been described. The most advanced fruits seen by me were still attached to the branchlets, but they occur far back from the growing point, on a portion from which leaves have fallen. Sometimes the same tree also bears half-developed fruits, which are more distal on the branchlets but still below the flowers. Thus one may observe specimens at full anthesis with flowers associated with the foliage, with half-developed fruits somewhat lower on the branchlets, and with essentially mature fruits still lower. In such cases fruits in an intermediate stage of development were not found, and this may incline one to suppose that two seasons (but not necessarily two calendar years) are needed for fruits to reach maturity. When essentially mature and apparently ready to fall from the tree, the fruits are rich pink to purple in color, falcate-oblong-ellipsoid in shape, and up to $10.5 \times 4.5 \times 4.5$ cm. in size. I did not observe dehisced fruits attached to the tree, but some which I dislodged were later observed, on the forest-floor, to have dehisced along the ventral suture. The elaborate vascular skeletons of decayed fruits were sometimes found, and these were always wide open along the ventral margin. Hence we feel sure that our original mention of the fruit as indehiscent is inaccurate. The pericarp, except for its hard outer layer, is very thick and fleshy, becoming greatly shriveled in drying. The “waxy irregularly lobed appendages” which we originally described and figured as arising from the endocarp are actually merely irregular remnants of the carpellary wall. Most of the ovules appear to develop, but only rarely are as many as 32 seeds to be found in a fruit. The fresh seeds are up to 16 mm. long and 12 mm. broad; their outer coat is thick, smooth, waxy, and bright orange-red in color.

HABITAT

Degeneria vitiensis is among the largest trees of the Fijian rain-forest. It has been observed on flat land as well as on extremely steep hillsides, on well-drained soil in undisturbed forest. The Fijian forest reaches its best development under very equable climatic conditions, as demonstrated by Tables 1 and 2, in which temperature and rainfall statistics are given for a few selected localities in the forested portions of the two large islands. The annual variation in temperature is comparatively slight, and alti-

TABLE 1
 Temperature statistics of selected localities in Fiji, from records
 of Meteorological Department, Suva

PLACE, PROVINCE, ISLAND	NO. YEARS COVERED BY RECORD	MEAN TEMPERATURE ° F.	ABSOLUTE MAXIMUM ° F. AND MONTH	ABSOLUTE MINIMUM ° F. AND MONTH
Suva, Rewa, Viti Levu	56	77.1	98 March	55 July November
Nandarivatu, Mba, Viti Levu	5	68.3	85 February March	45 July

TABLE 2
 Rainfall statistics of selected localities in Fiji, from records
 of Meteorological Department, Suva

PLACE, PROVINCE, ISLAND	NO. YEARS COVERED BY RECORD	NORMAL ANNUAL RAINFALL (INCHES)	NORMAL NUMBER OF WET DAYS	NORMAL RAINFALL (INCHES), WETTEST MONTH	NORMAL RAINFALL (INCHES), DRIEST MONTH
Suva, Rewa, Viti Levu	51-57	120.86	246.8	14.73 March	5.41 July
Nasinu, Naitasiri, Viti Levu	11-15	129.51	220.5	16.95 April	4.98 June
Vunindawa, Naitasiri, Viti Levu	20-33	140.10	175.6	17.16 December	4.14 July
Nandarivatu, Mba, Viti Levu	19-45	137.63	176.3	25.06 February	3.56 July
Wainunu, Mbua, Vanua Levu	20-66	146.46	199.0	18.23 January	5.64 July
Yanawai, Mbua, Vanua Levu	8	202.34	237.0	22.01 May	13.14 June
Salialevu, Thakaundrove, Vanua Levu	11-25	213.57	183.5	20.99 October	13.63 July

tudes up to 800 m., that of Nandarivatu, produce an average fall in temperature of only 10°F. as compared with localities at sea-level. Rainfall is well distributed throughout the year in the forested areas of Fiji, and even in the driest months four or more inches of rain may be expected. For permission to reproduce these statistics I am greatly indebted to Mr. Ralph Dyer, Director of the Meteorological Department in Suva.

The forest inhabited by *Degeneria* cannot adequately be characterized by mention of any single species or any small group of species; it is greatly diversified, although sometimes locally dominated by the *ndakua* (*Agathis vitiensis*), conspicuous by its comparative great size. The more frequently observed components of this forest, as seen in north-central Viti Levu, may be mentioned as follows:



DEGENERIA VITIENSIS Bailey & Smith